A Virtual Impactor for Reducing Particle-Related Artifacts During Mercury Sampling

by

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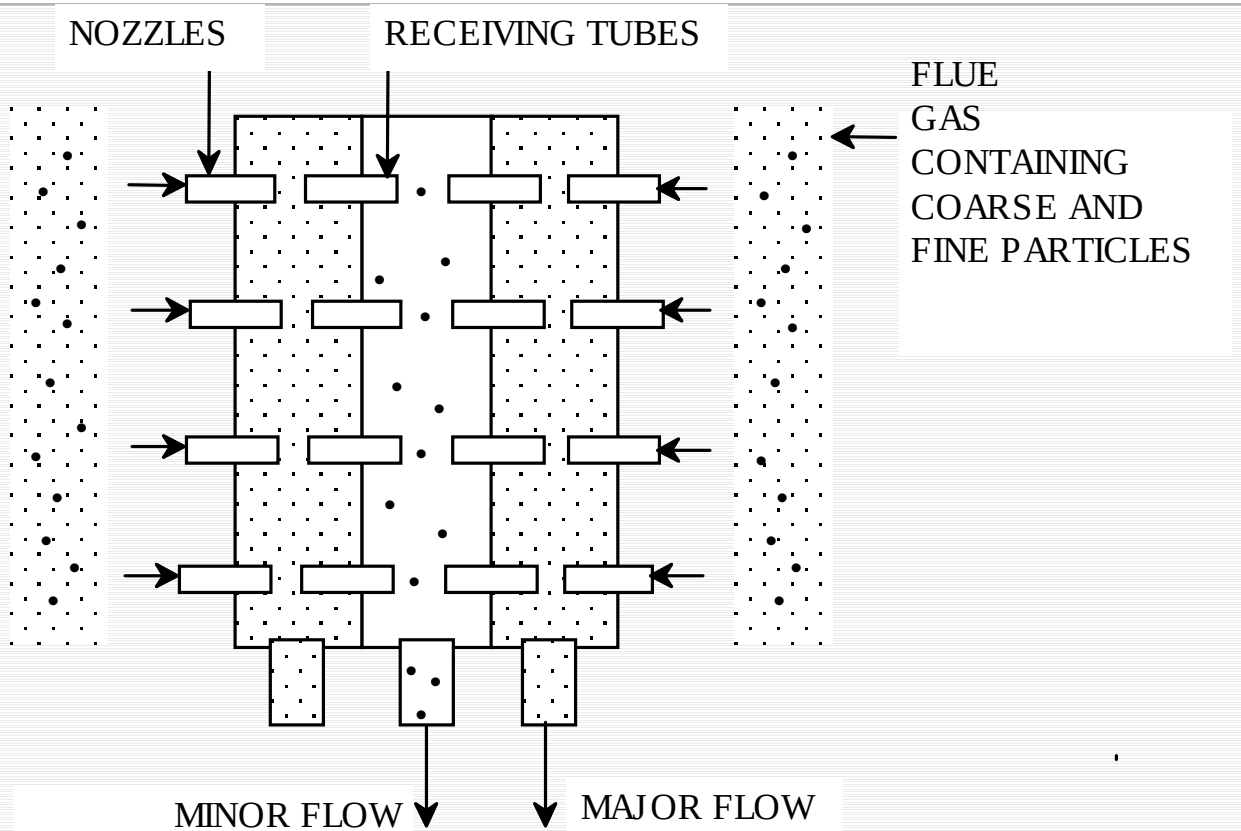
So What's the Problem?

- Proper understanding of the chemical form of mercury is critical to predicting its behavior in control devices and in the environment
- Particulate matter affects the chemical form of mercury (elemental converts to oxidized; possibly oxidized converts to elemental)
- How does one get a representative sample to a real-time analyzer with the particle loading typical of coal-fired power plants?

Options for Particle Removal

- Filter – packed bed of accumulating particles
- Cyclone – particles accumulate in base; intense swirl of particles with gas before disengagement
- Electrostatic collector – possible but particles accumulate still
- Cascade impactor – gas passes over accumulated particles

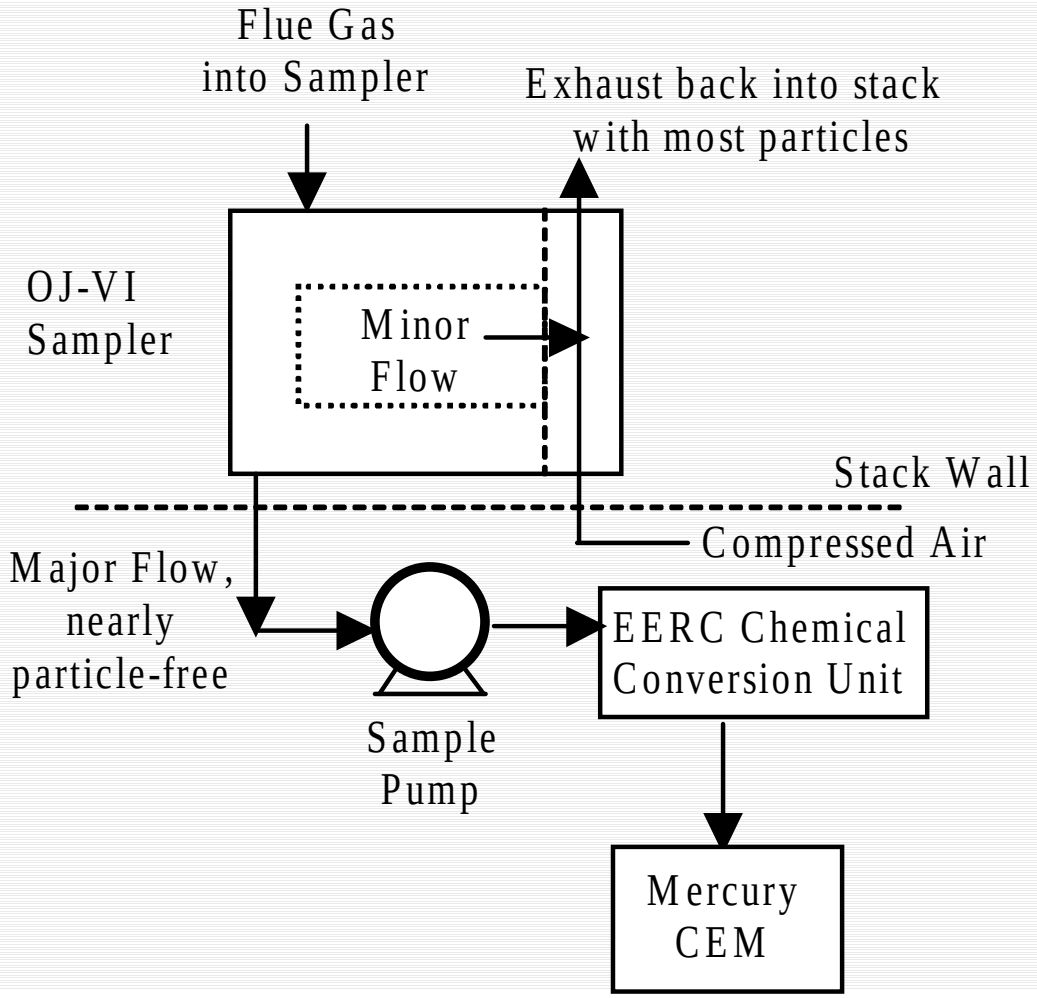
The Virtual Impactor Option



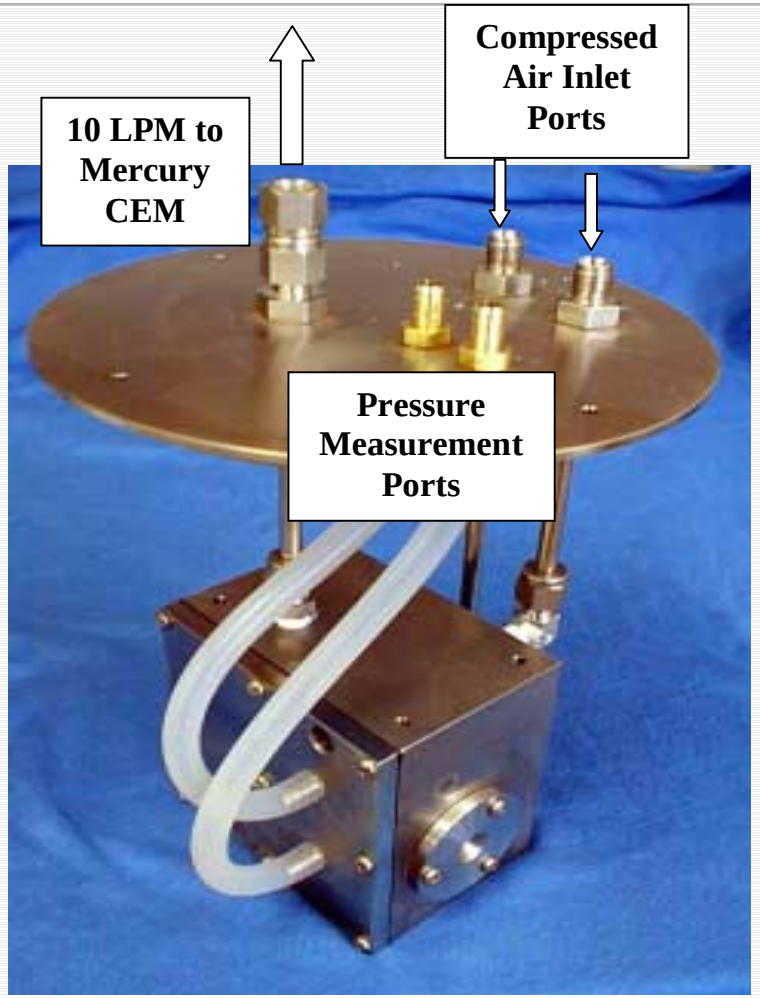
Advantages of Opposing Jet Virtual Impactor

- Power consumption reduced by “n” to the two-thirds power
- Particles decelerate in free space, reducing wall losses

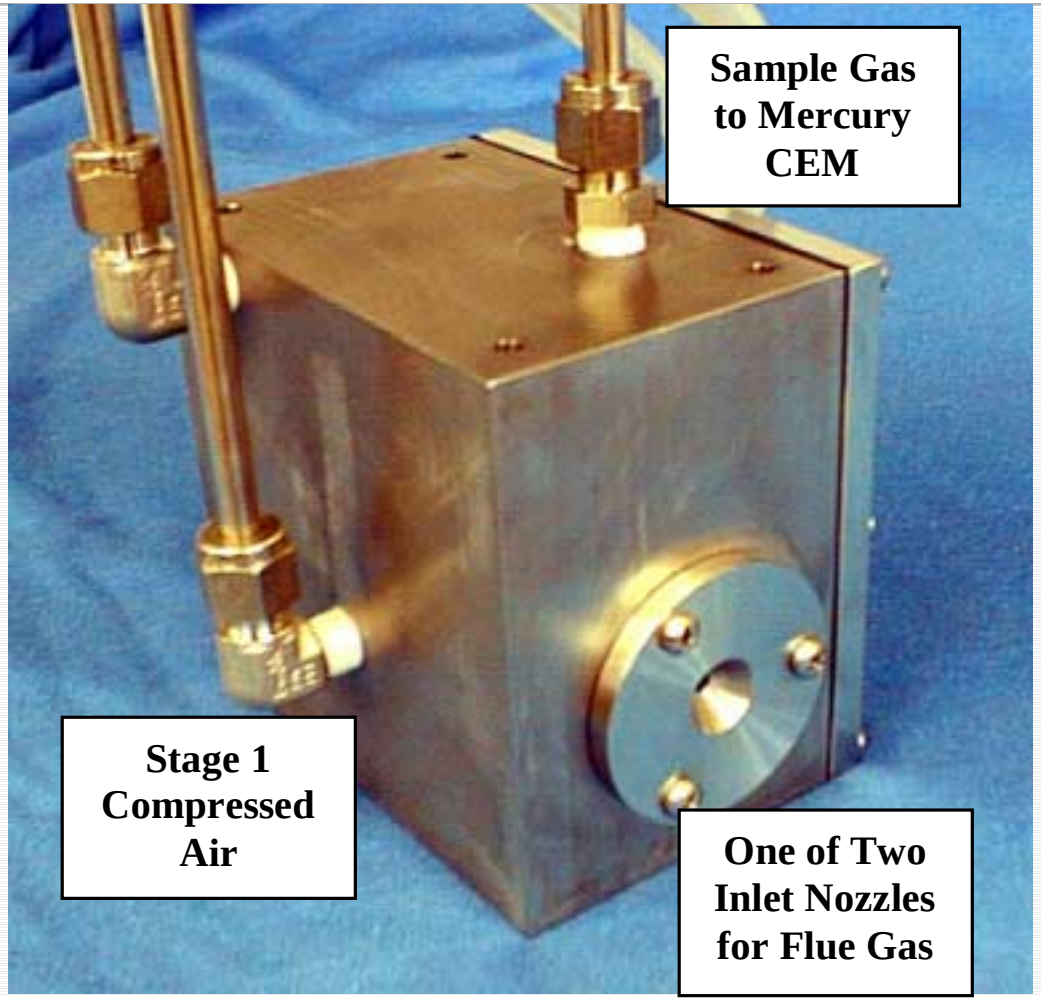
Overall Sampling Scheme



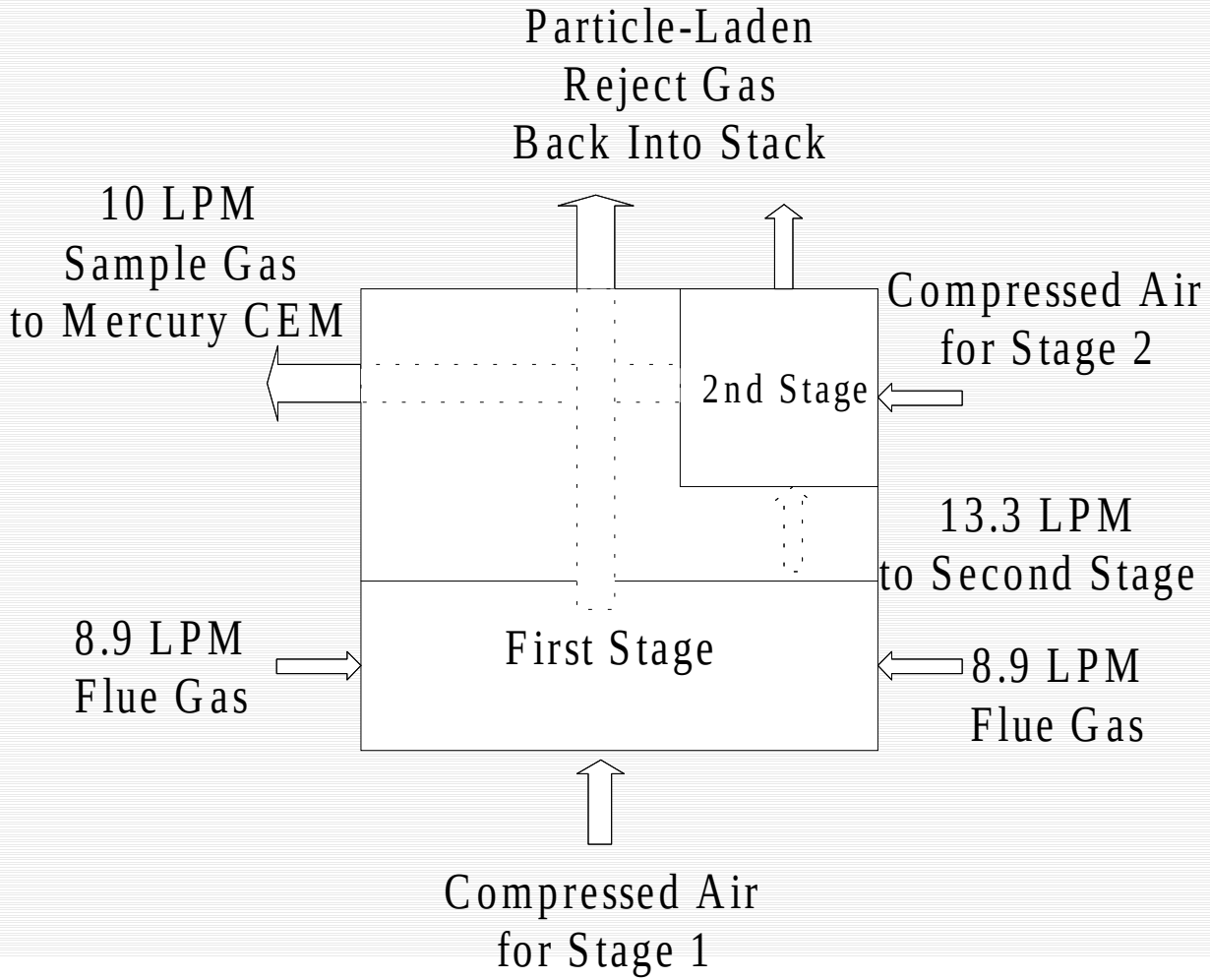
Attachment of Sampler



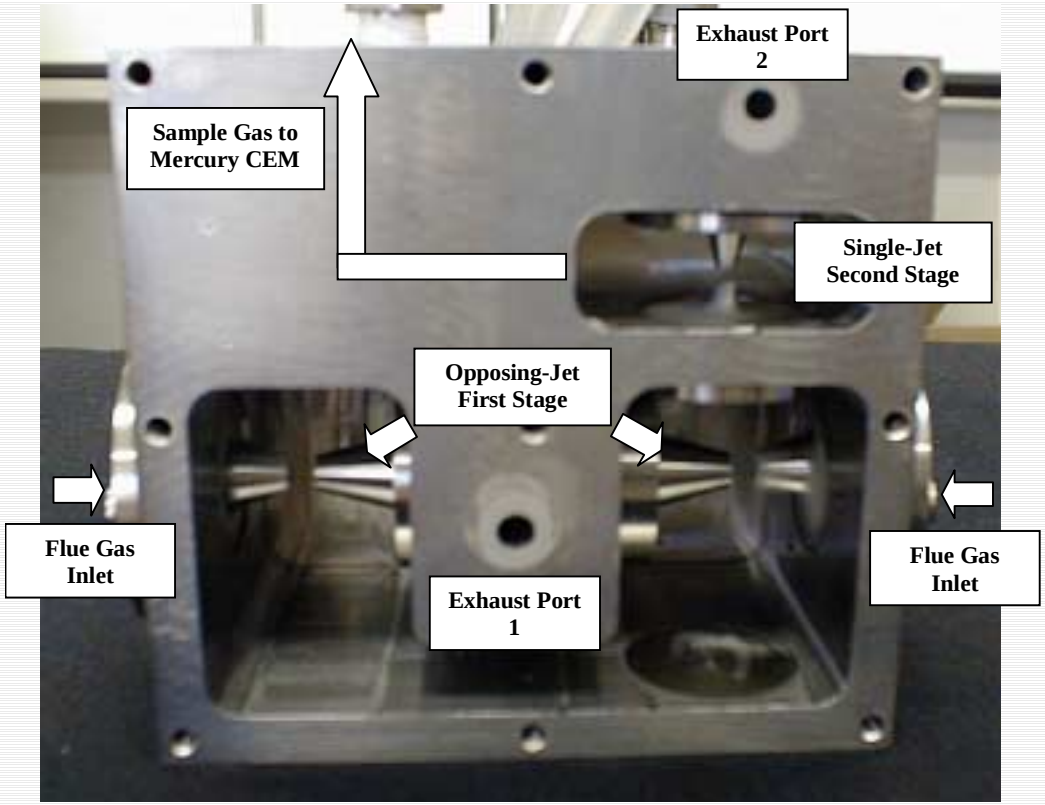
Close-Up of Sampler



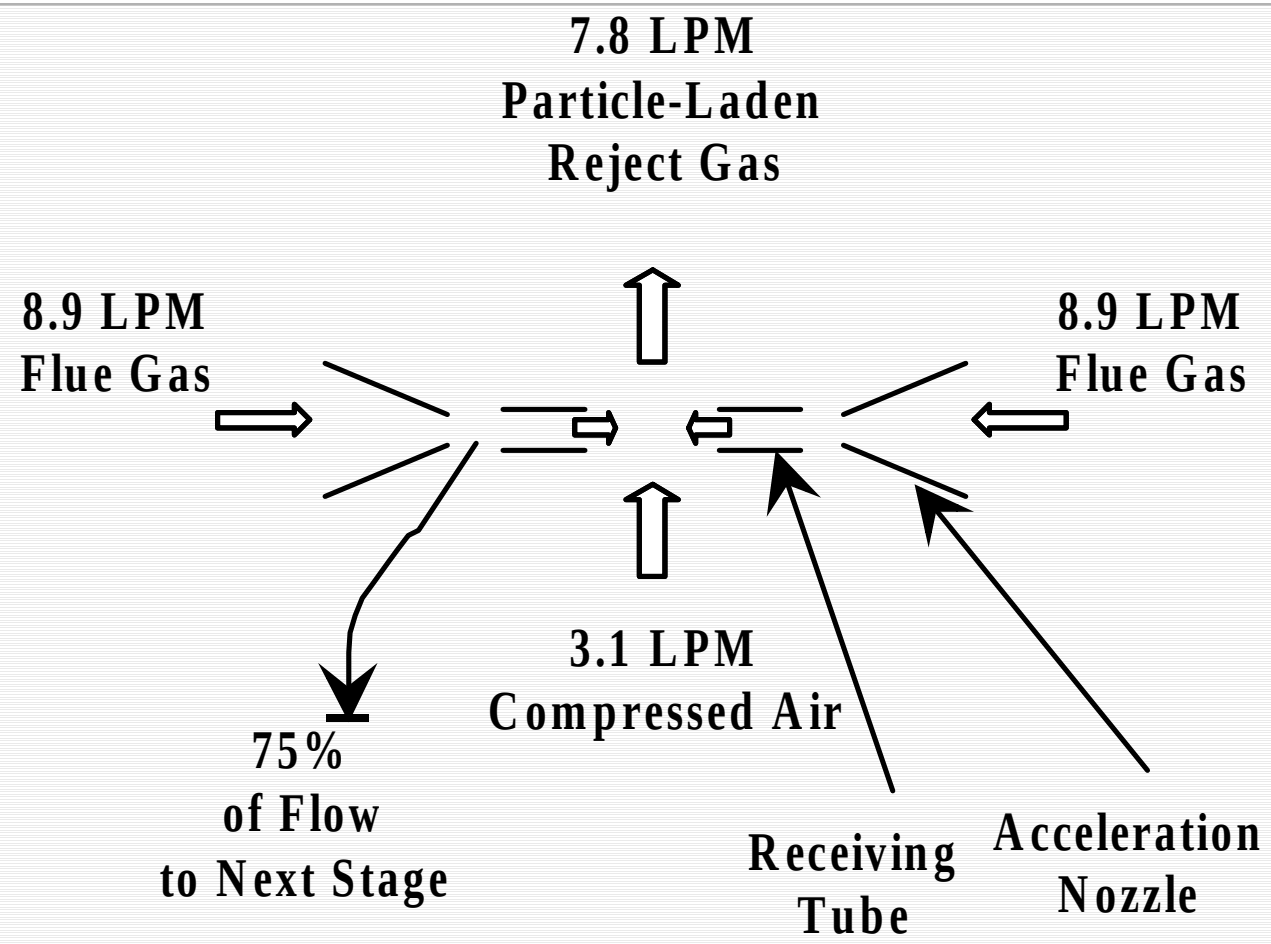
Flow Inside OJ-VI



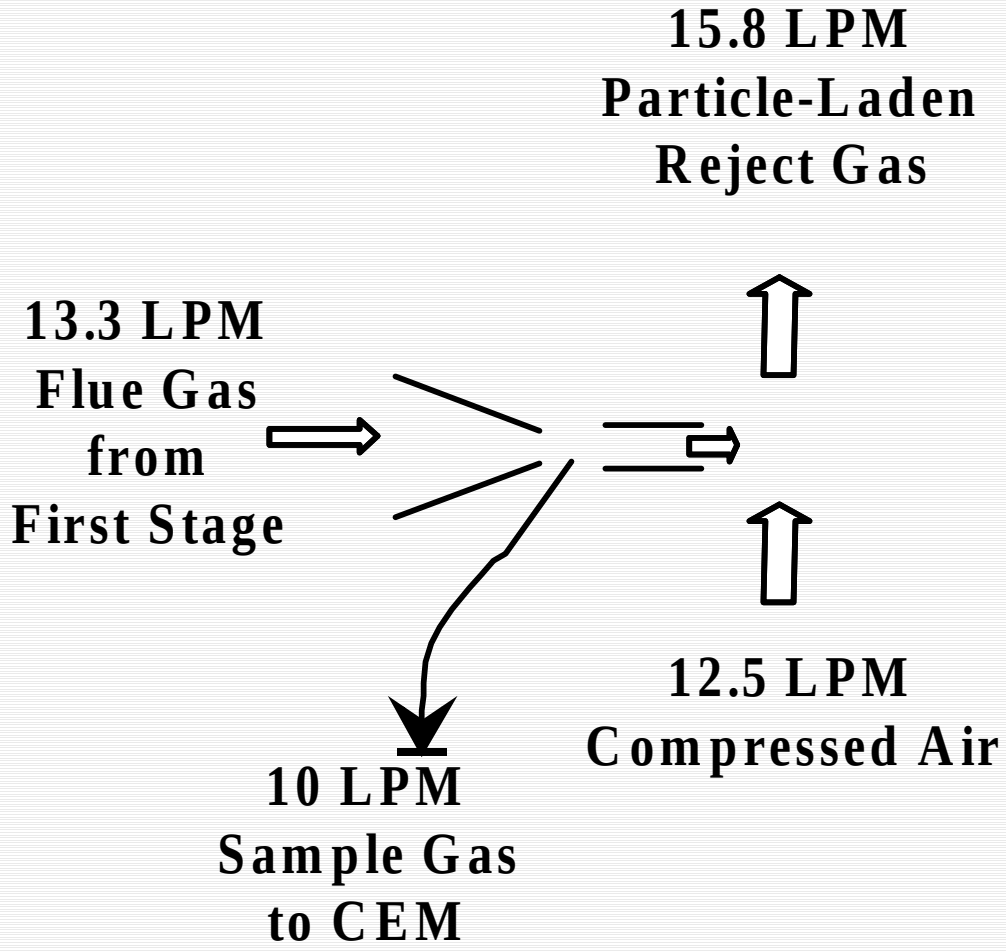
Nozzle Arrangement in Sampler



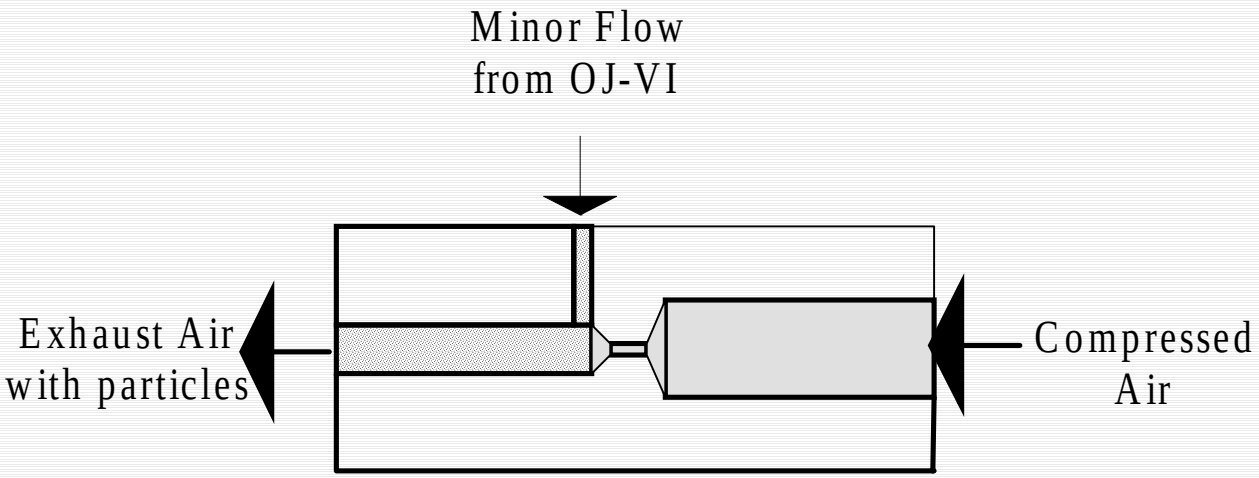
First-Stage Nozzle Flows



Second-Stage Nozzle Flow



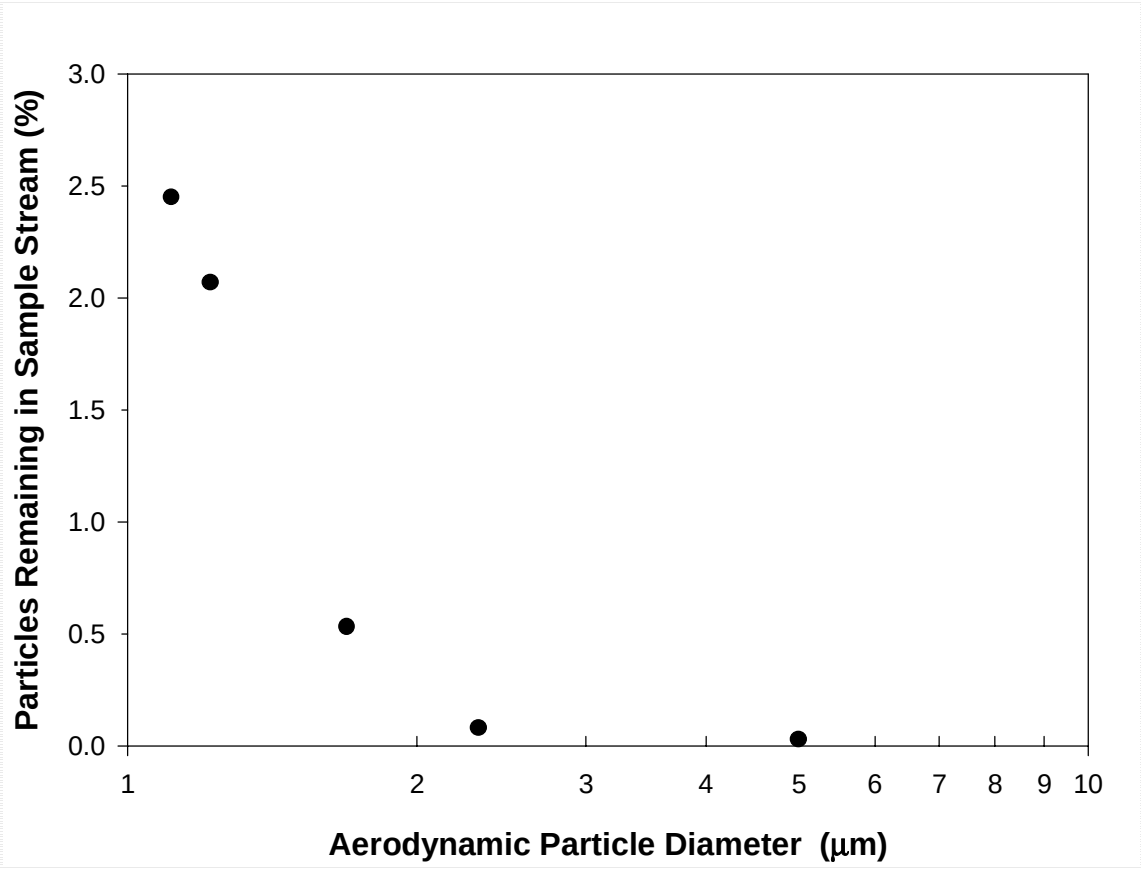
Reject Gas Flow Method



Nozzle Details

Cut Point (µm)	Diameter of Acceleration Nozzle (mm)	Diameter of Receiving Tube (mm)	Design Pressure Drop (inches of water)
0.5	1.43	2.00	76
1.0	1.91	2.67	8.6
2.0	2.92	4.09	1.6

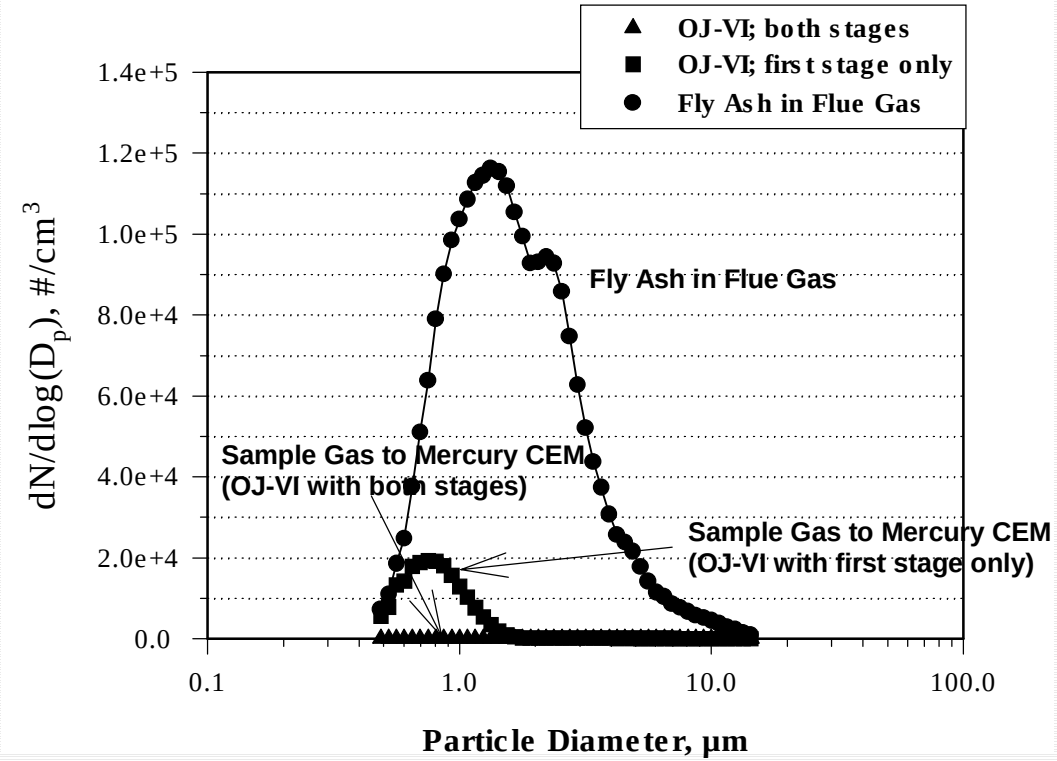
Monodisperse Particle Behavior



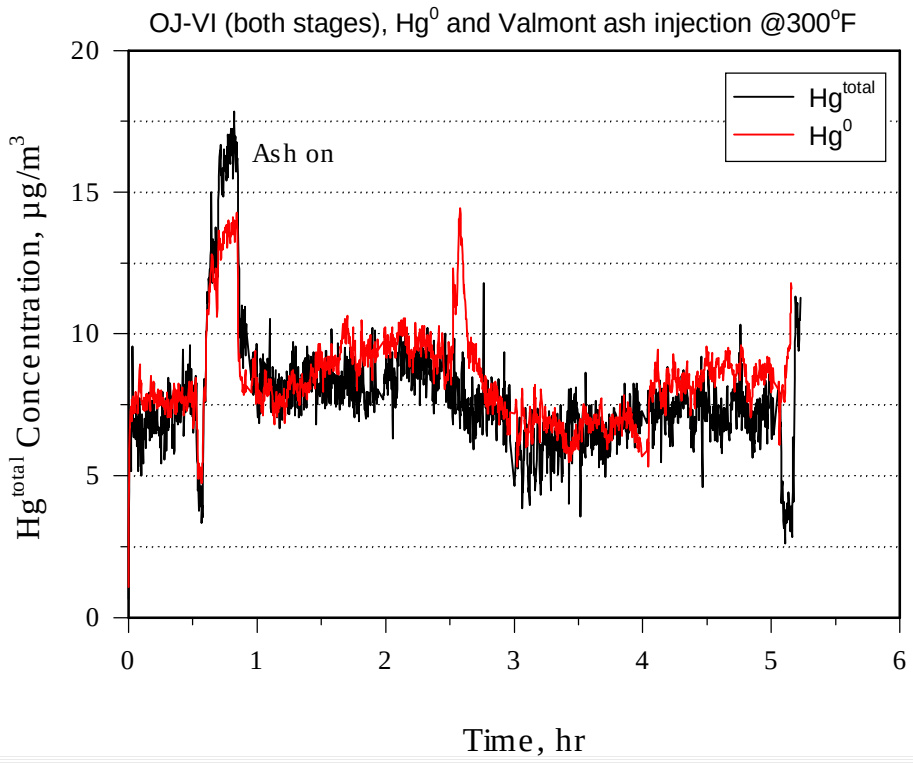
Test Program at EERC

- Synthetic Flue Gas – particles, HCl, NO, NO_2, water, SO_2
- Either Hg^o or $HgCl_2$ at 7.5 µg of mercury per m^3
- 300°F; 2 grains/ft^3 particles (4.5 g/m^3)

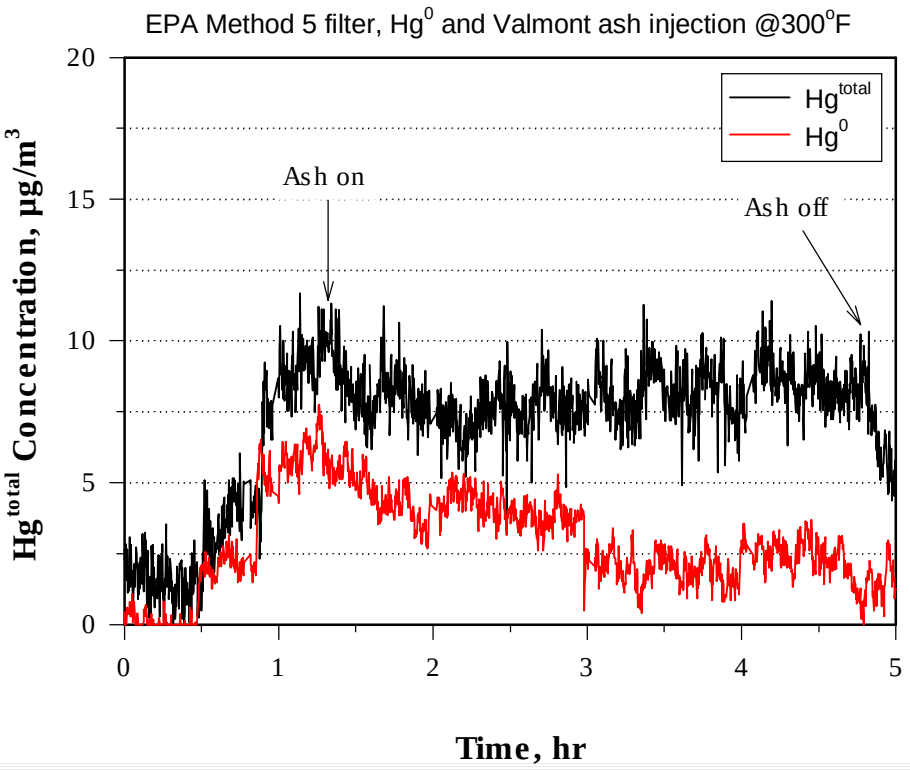
Fly Ash Particle Behavior



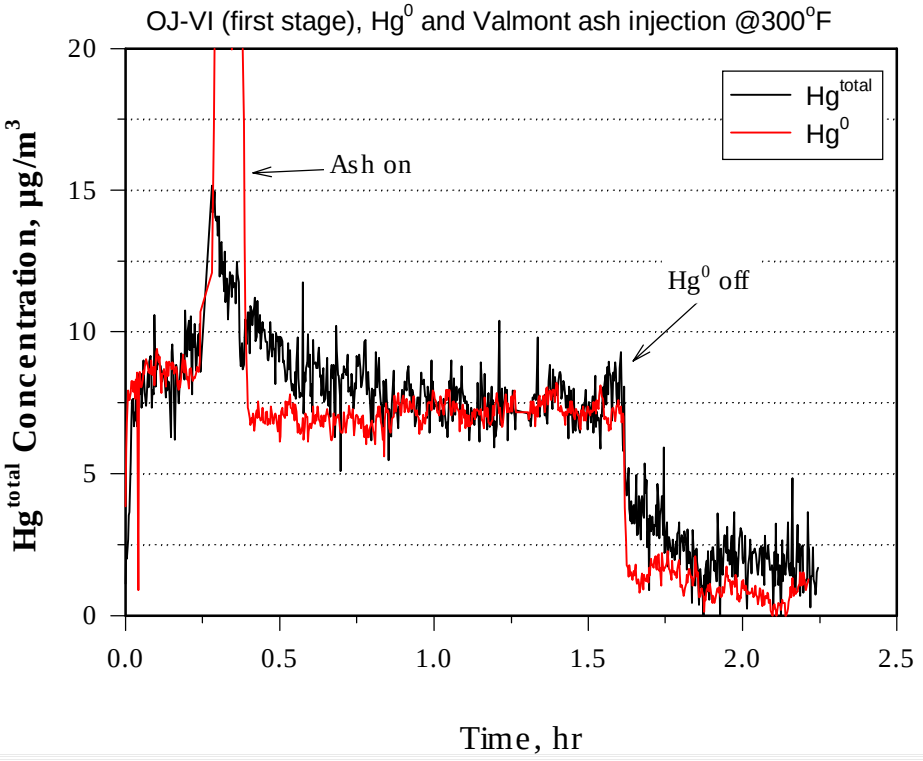
Stability of Hg^0 – Two-Stage



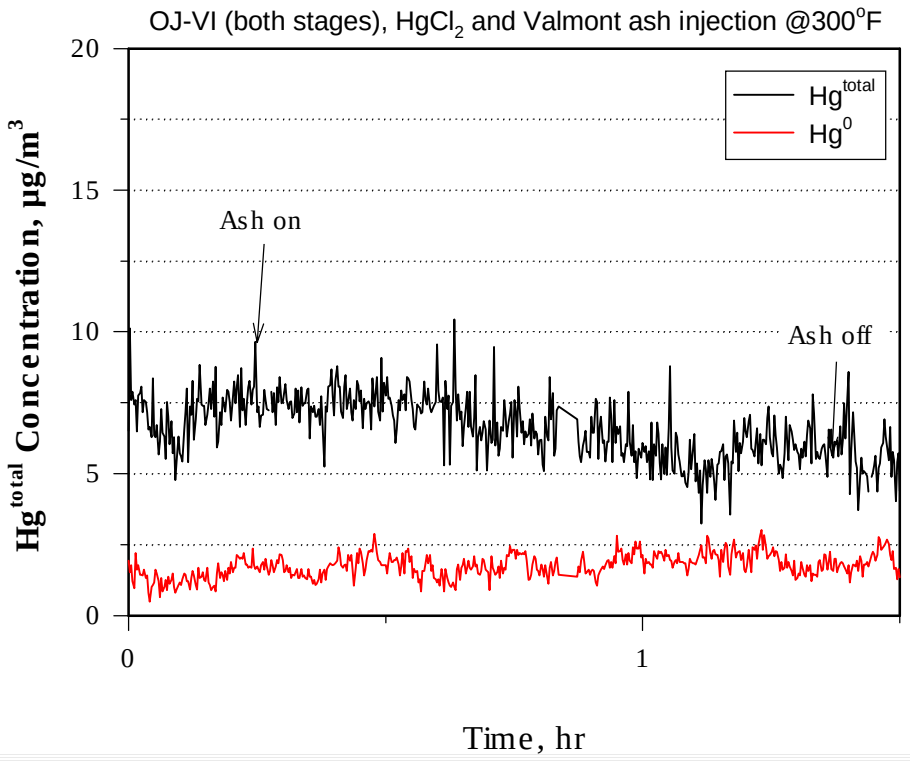
Conversion Across M-5 Filter



Stability of Hg^0 – Single Stage



Stability of $HgCl_2$



Future Work

- Longevity in Field Use
- Backpulsing for cleaning
- Field-able test unit
- Pilot and Field Testing

Revised Sampler with Back-Pulse Air Capability

Sampler Module

Inside of Sampler Module

Side View, Pump in Back